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ABSTRACT

This paper describes the characteristics of "smart schools" and offers guidelines for developing such schools. Smart schools are defined as having three features: (1) they are computer networked via local area networks in order to share information through teleconferencing, databases, and electronic mail; (2) they are connected beyond the classroom to other schools and organizations in the city, region, state, and world; and (3) they are adaptive to serve teachers, administrators, and students and provide artificial intelligence and neural network technologies. The computer hardware, software, and networking for a pilot project in Bethel High School in Hampton, Virginia, are described and information services, electronic resources, obstacles, administration, and plans for the future are discussed. Strategies are also suggested for implementing smart schools elsewhere. The appendix outlines the premises that underlie smart school development and lists characteristics of future students, teachers, and administrators in such schools. (DB)

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Implementing Smart School Technology at the Secondary Level

Hampton City Schools
Hampton, Virginia

by

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Implementing Smart School Technology at the Secondary Level
Hampton City Schools
Hampton, Virginia
Dr. Charles K. Stallard

We are pleased in this session today to tell you about the efforts we in Hampton City Schools have mounted over the past couple of years to help us define how our schools should look and work in order to meet the needs of citizens of the Information Age. Our district is deeply involved in the process of restructuring. We feel that one of the most significant aspects of our restructuring is that technology is at the heart of the process.

When I came to the division two years ago, I found a computer to student ratio of about 35:1. The technology being used was old, primarily Apple II and 8 bit MS DOS computers. They were being used for Computer Assisted Instruction, or drill and practice, and the district was offering "computer literacy" classes. Some students worked in computer labs if they were special, special in the sense of being gifted, at risk, or needing special education services. Some others took computer literacy classes or went for "remediation," which meant that they would be assigned specific lessons or specific packages of software intended to redress some reading or math deficiency. These uses of technology are neither bad nor ineffective, but as a paradigm or model, interactive technology was being used as an audio-visual aid or supplement to traditional teaching and learning practices.

After we looked at the way we were using technology in the district, we came to the belief that before technology can begin to make a significant difference for our students and staff, we must first experience a paradigm shift in the way we think about technology and the day-to-day operation of schools. The model that we developed in the Hampton School division makes interactive technology part of the fundamental infrastructure of the the school and not just another audio visual aid or supplement.

We realized from the outset that we would be involved in a long term process of change. We did not then and do not now expect sudden and wonderful change to overwhelm our division. Instead, we have embarked on a journey that we hope to complete by 1995. Our plan necessarily calls for small and moderate steps. The reality is that we do face systemic resistance to change. We are confronted with the problem of limited resources, and many people adhere to the old paradigm with tenacity.

We have embarked upon a road to the creation in our district of what we have chosen to call Smart Schools by 1995. Bethel High School has been chosen to pilot test the technologies and ideas that underlie our concept of smart schools. In the rest of this presentation we will define what we mean by the term smart school, how we are going about implementing the concept.

I. Smart School Defined

Smart schools possess electronic infrastructures for the flow of information. These infrastructures provide access to teaching and learning resources within and outside the school building. Smart schools allow students and teachers to play very different roles in the classroom. Appendix A describes the major roles we see students, teachers, and administrators carrying out in our smart school.

A Smart School Has Three Defining Features

1. **Networked**
2. **Connected**
3. **Adaptive**

1. Networked (Local Area Networks)

Local area networks provide an electronic pathway for information in all forms (voice, video, data). The pathway allows for the movement of information throughout the building--in all directions--and allows resources appended to the network to be shared. Networking opens the doors for interpersonal computing and promotes collaborative teaching and learning.

Our Goals for Networking

a. Leverage Resources and maximize use
   - Laser and other networkable printers
   - Networked versions of software
   - Network modem & phone lines
   - Networked CD ROM Players

b. Share Information
   - Databases for specific subject areas (Hypercard Stacks)
     - Social Studies
     - Science
     - Literature
   - Electronic encyclopedias (Groliers, Compton's)
   - On-line Card Catalog
   - Administrative Data

c. Promote Collaborative Teaching and Learning
   - Class and building level work groups (shared data files)
     - School Newspaper
     - Yearbook
     - Literary Magazine
     - Group Projects and Reports

II. Connected to a Much Broader Information Community

Beyond local area networking, a Smart School incorporates a system for communication that extends beyond the walls of the classroom to other schools and organizations in the city, the region, the state, and the world. The connections employ a variety of connective media to include satellite, broadcast and cable television along with data communications by phone and microwave.

Our Goals for Connectivity:

a. Provide a variety of systems for electronic mail
b. Provide access to an electronic classroom (two-way audio; one-way video)
   - Remote instruction or distance learning
   - Teleconferencing
   - Remote work groups
c. On-line resources such as Dialog, Compuserv, etc.
d. Voice mail at the individual classroom level
e. Provide access to information resources for teachers and students from home via modem and computer workstation

III. Adaptive to Individual and Unique Needs of Individuals

The adaptive part of the Smart School has been the most difficult to explain and to envision. What we have in mind is a system that provides access to demographic, performance and achievement data for teachers and instructional leaders who will monitor individual students much more closely than they do now. Eventually the system should grow in capability to allow us to develop individualized curriculum plans or IEP's for every student. As artificial intelligence applications become more widely available, we even expect the system to provide some degree of regular and independent monitoring of individual student progress without being queried by the instructor or administrator.

Our Goals for Using Technology to Adapt Schools to Children

Alvin Toffler writes about a process he calls "demassification." In the Information Age, everything is demassified. People are given more choice about products, service, providers of product and services, etc. Technology has the potential to provide students with much more personalized choices in their curriculum and how it is taught and how they learn.

We envision three stages or three levels of adaptiveness as we progress.

Level 1--Teachers/Counselors/Administrators initiate a query about a student or a class and develop IEP's in special cases. In order to accomplish this task, we have installed an IBM 9370 and a master student data base built on SQL. Each guidance counselor and principal has access to this data base using QMF or Query Management Facility. Secondary schools are networked to the mainframe at the building level on IBM System 36's with 5 to six terminals for administrative use. Elementary schools have mainframe access with microcomputers and modems.

We have fully implemented Level 1 in 1991.

Level 2-- At this, higher level, individual teachers and all instructional leaders have access to the master student data base using a graphic interface where data can be secured by simple point and click techniques. The existing SQL/QMF requires significant effort and study to extract information from the data base. At Level 2, students may themselves have some access to personal data for self-monitoring. Students may have access to QPA, SAT, CAPT, PSAT scores, for example, and better understand their weaknesses and strengths.

We are currently doing feasibility studies on how to accomplish this level of adaptiveness.

Level-3 At the highest level, artificial intelligence and neural network technologies will be implemented so that the system
"learns" about students as they interact and may even draw information from the master student data base about groups and individuals. Such a system should be able to generate IEP's, and, perhaps, offer tutoring for the student as it "sees" the need. We realize that this level of instant adaptivity may be some time in coming, but the networking and connectivity infrastructure we are building now should take such possibilities into consideration.

Hardware Overview of Bethel Pilot Project

Our installed base of Apple II computers was repositioned into elementary schools. We installed Macintosh labs in areas where labs seemed to make sense, writing, math, and journalism. We placed networked workstations in teacher work rooms, teacher resource rooms, departmental offices, and administrative offices. Laser printers were placed in a

computer workroom in the library where the building level Network Administrator could help individuals new to the technology.

During the first year we installed independent Appletalk™ networks, but soon found that we needed more speed and power than Appletalk™ could give us. During year 2, we upgraded to Appleshare on Ethernet. See Figure 1.

MS-DOS machines were in use in the business and vocational areas and continue to be used there. We have not, however, added these to the network at the present time.

Software Overview of Bethel Pilot Project

We have standardized software wherever possible through site licenses and network versions. We find that this facilitates training and support and also reduces cost. Our choices include the following:

Microsoft Works Pagemaker MacDraw

Alexandria for On-Line Card Catalog and Library Management

Subject Specific Software for Math, Science, and Writing

Utility software includes GraceLAN for network management and Remote Timbuktu for support from the district coordinator's office,

Network Overview of Bethel Pilot Project

The local area network at this stage of development consists of three file servers (Macintosh SE 30's), and one hundred and thirty Macintosh Classic and LC computers networked via Ethernet on 10 base T. We still run Appleshare ™ on the Ethernet. These computers are located in computer labs (15-17 per lab), administrative offices, teacher workrooms and departmental offices, the library media center, and in many individual classrooms.

We used a thin net coaxial backbone (10 base T). Asante concentrator hubs take Ethernet on unshielded twisted pair wire to the individual machines. NuvoTech Ethernet adapters are connected to individual machines via the SCSI port. In two cases, labs remain on Appletalk and are joined to the Ethernet backbone via Shiva Ethergates. Three CD ROM drives are attached to the network where the network administrator can mount particular volumes for remote use as needed or requested. Shiva netmodems provide e-mail and bulletin board access for teachers, administrators, and students.
Dot matrix and laserwriter printers are available on the network as well and are placed in various places in the building.

Information Services Available on the Network:

On-line library card catalog using the Alexandria™ library management software has been a popular tool. In addition we have access to two major university library card catalogs for bibliographic research, the University of Virginia and Virginia Polytechnic and State University. Each secondary school also has access to the resources of DIALOG. The network modems provide access to two state information services. VA.PEN provides electronic mail and bulletin board free of charge to all Virginia schools. We use it for inter- and intra-school communications. Teachers and students frequently read and post "news" on the bulletin board. VA.NET provides access to numerous federal bulletin boards and has been used for communications with the Department of Education in Richmond. We continue to build our collection of networkable CD ROM discs, primarily in the areas of social studies and science.

Non-Network Electronic Resources

In addition to networked resources, we have a number of stand alone electronic tools in use at Bethel. Groliers Electronic Encyclopedia, Compton's Multimedia Encyclopedia, NewsBank CD ROM, Scanners, Level III Interactive Video Video Projection (RGB and LCD). Our electronic classroom in equipped with a steerable satellite dish. The Department of Education offers a variety of courses for high school and advanced placement credit through the electronic classroom. In addition we use it for foreign language news broadcasts, teleconferences, and staff development activities. The electronic classroom is equipped with a speaker phone, fax machine, networked Mac workstation, and we have standard coaxial cable to all classrooms.

Network Administration

Network administration for the local area instructional network falls to one of the two school librarians. She is backed up by the Director of the Writing Lab. The Directors of the Math and Journalism Labs are also developing network administration skills. We have found that we need redundancy in this function to cover those times when the network administrator is unavailable. Once users come to depend upon a service, we have to maintain it.

New Developments Planned for the Immediate Future

Our goal is make the school more adaptive to individual needs. In order to accomplish this we need access to the information that will reveal what those needs are. We are examining a product called DAL (Data Access Language) which is a front end for SQL databases. DAL brings the user friendly Macintosh interface to the task of extracting information from mainframe computers. DAL should enable us to provide what was described above as Level 2 adaptiveness within the coming months. It is also our goal to provide secondary students access to the Hampton Public Library card catalog and other local university card catalogs. We also are installing smart school technologies in other schools in the district, and during 1991-92 we will begin to implement an internet or wide area network. Using network modems and/or devices called bridges, we will enable users in one school to employ resources in other schools on the internet. We see the internet as a logical extension of smart school technologies. In this respect our goal is a "Smart District."

Obstacles We Have Faced

- We have had resistance to the changes we have implemented. Some people feel that the time, trouble, and effort required to make the transition is not worth the gains the technologies afford. Others feel that the "technology thing" is going to be another short lived educational innovation and not worth their attention.

- Still others have used state requirements and mandates as excuses for not taking time and effort away from traditional programs and practices. At the same time, we have received only support and encouragement from our State Department of Education.

- Training is a mammoth task. Rather than getting simpler as more and more teachers and administrators gain expertise with the systems, the problem is compounded when skilled users develop more complex and sophisticated support needs. Finding expertise to provide adequate levels of training in enough quantity has been a problem. One approach we are using to deal with the problem is a train the trainer program. We have also joined a Consortium of universities, other school districts, and private schools to mutually sponsor training programs.

• Cost has been a major obstacle from the beginning, yet we have progressed to our present level with local funding. A minimal investment in smart school technologies as outlined above would be well in excess of one quarter million dollars. A key strategy has been our ability to reposition older technologies into programs that do not require networking and connectivity in order to be carried out. This has freed funds for smart school use.

• The old paradigm where the teacher is the sage on the stage persists.

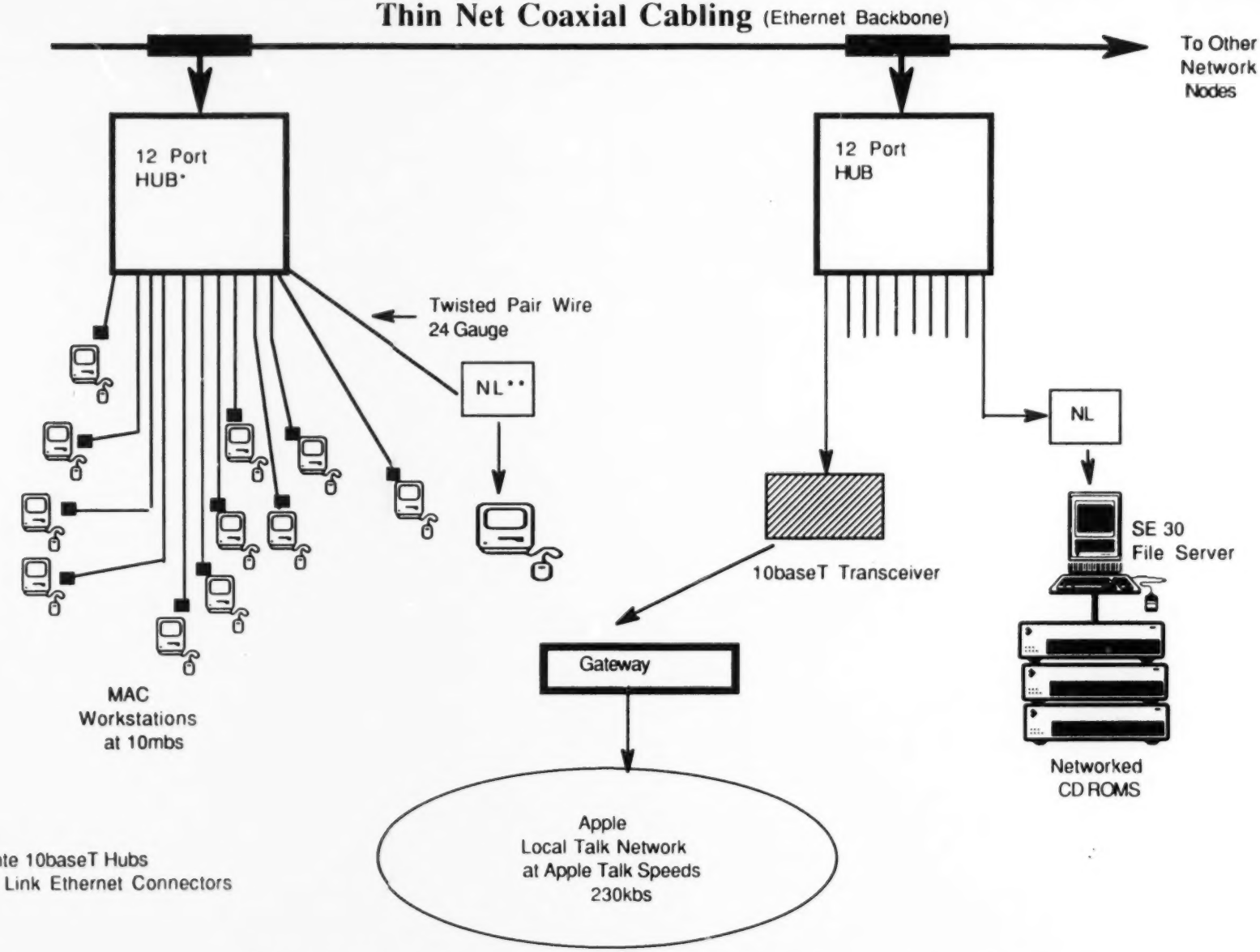
Some Strategies We Have Used to Implement Smart Schools

One of the first activities was to identify individuals anxious to become involved with technology. These have become agents for change in their individual buildings. We have encouraged our technology leaders to build coalitions among interested faculty and administration. The approach as been most successful. While some continue to resist, most faculty and administrators in our smart schools are anxious for the next level; the next infusion of technology tools to work with.

We have sponsored site visits to a number of other districts so our innovators could see technologies in operation, for good and for bad. Our Consortium for Interactive Instruction has been vital in providing travel opportunities, regional conferences, and training. By joining with a number of other districts, we have been able to afford opportunities that we could not alone.

We have had an extensive program of pilot programs within the district to test applications and hardware and software configurations. Our district technology Preview Center has also been instrumental in training and in demonstrating a wide variety of applications.
We have taken every opportunity to make presentations about smart school technologies to our district administrators and the school board. We have been sure to utilize the technologies to the utmost in these presentations. The school board has responded with policy and priority statements about technology that has given our efforts the credibility they needed to succeed.

FIGURE 1



Bethel High School Network Segment 1 and 2
Six Segments Installed in Phase II

APPENDIX A

Premises That Underlie Smart School Development

Students are active learners. They create and produce as they learn. When they are intellectually engaged in their work they try out new ideas, and they construct knowledge from the world around them. Students need to act more often as pilots rather than passengers through their educational journeys.

Teachers need to guide and facilitate that learning. They need to organize and direct learning experiences more than they need to "tell" students the content of a discipline. They should actively coach students through their work, set objectives, and accept responsibility for their students' progress. Teachers are at the center of the learning process and of the life of the school.

Changes in both the quantity and the nature of information is transforming society. Information is rapidly assuming digital form. Students and teachers must have constant access throughout the school day to information they need for learning. Information needs to be available quickly, from a variety of sources, in a variety of modes, and at the times and places where students and teachers work.

Students must acquire certain fundamental ideas as a foundation to continued learning. They need to to discover and construct such ideas from their work in school, and start doing so from the earliest years.

Students learn in many ways. Education should develop all of the aspects of human intelligence. Ideas can be embodied in many forms to help students learn them. Students should build and express their knowledge through a variety of media and in a variety of styles. Teachers should use a variety of methods and tools in their work.

People learn all through life. Learning occurs at home, in school, on the job, and at play. Schools must build in students a desire to learn that follows them well beyond the schoolhouse door.

Students can learn whatever they wish, whenever they wish, wherever they are. The school must become a learning society. No topic should be inaccessible in the school; all subjects need to be organized and available for immediate use by both teachers and students.

Students learn well together. Some of the best learning occurs in groups, where students cooperate to discover a concept or build an idea. Students can effectively teach and coach each other. Students need many opportunities to communicate and present their ideas. Skills of collaboration are increasingly important in the modern world, especially the workplace. Collaborative skills should be built early.

Learning should be connected. Ideas from many disciplines need to be linked together naturally in the day-to-day activity of the classroom. At all ages, students should explore concepts and learn skills though units and projects that combine several subject areas and speak to the common experiences of the human species.

In Smart Schools of the future students should be:

- using computers as tools throughout the day and throughout the building to perform the everyday tasks of learning: writing, drawing, finding information, analyzing data, sending and receiving messages.

-accessing, throughout the school day, a standard set of learning and production tools: word processing, draw and paint tools, spreadsheets and databases, using high-quality printing along with a wide range of hypermedia and multimedia resources

-accessing student workstations so that waiting time is seldom necessary

-using student workstations located in a variety of locations in classrooms, in labs, in the library, and throughout the school building during instructional time as well as during study hall, lunch breaks, and before and after school

- using a variety of software tools to conduct investigations, solve problems and complete assignments in all subject areas

-completing language arts writing assignments on the word processor, math problems with the aid of a spreadsheet, organizing history facts into databases, producing artwork with painting programs, graphing science experiment measurements

- gathering information for their assignments from a variety of sources within and without the school

-using on-line access, from classroom or student workstations to query standard research tools such as encyclopedias, reference works, and collections of subject-specific information organized into databases or hypermedia files

-accessing other students' publications and information placed on their local area networks

-making use of subject-specific tools, such as MIDI instruments in music, computer-aided design and graphing in art and math, and desktop publishing in language arts

-using interactive multimedia learning and production stations, to review subject area materials, conduct research, and prepare reports and presentations that combine text, graphics sound, music, motion video, and still images

-using a variety of computer interfaces in their science laboratory courses, including temperature, pressure, electrical, light, and sound measuring devices, frequency counters and scales; all linked to a computer for immediate display and analysis

-using computer-aided instruction in a variety of subject areas

In Smart Schools of the future teachers should be:

-using teaching and presentation workstations in their classrooms. These workstations should run interactive video, CD-ROM, hypertext, and other multimedia software. In certain areas, such as music, the arts, science labs and graphics classrooms, the teaching station should include interfaces specific to the subject at hand. Teachers should store and print documents and graphics, and communicate with school-based and off-site databases and electronic mail services

- accessing data such as grades, attendance, and student schedules from their classrooms, in a manner that facilitates their record-keeping and information gathering

- searching and retrieving library and research resources from their classrooms. Both on-site (e.g., local databases, CD-ROM references, on-line card catalog, lesson plans, worksheets, tests, quizzes) and off-site (e.g., news, census, bibliographic, professional group forums) information should be made available on the school's network and through through commercial information services

- sending electronic mail to each other, to specialists, to administrators, and to students and their parents. This service should be available in each classroom throughout the day for teachers to communicate curriculum, student, and administrative information

- selecting and reviewing the most appropriate instructional software for the students at the teaching station(s) in their classrooms, or computer labs

- using generic software tools of word processing, desktop publishing, desktop presentation tools (including maps and graphics) to help them to prepare teaching materials and complete administrative tasks. All of these tools should be supported with high-quality printing and transparency preparation that is available from the classroom

- using teacher workstations with friendly and user-modifiable interface that allows easy "point and click" access to the most widely-used functions of the system

- using most of the above-mentioned functions from home or other locations through dial-up access.

In the Smart School of the future administrators should be:

- accessing the information they need for decision-making from desktop workstations. Financial, curriculum, and student-performance data, whether stored on the district mainframe on on a network server in the school, should be available from each administrator's personal computer; as should the tools necessary to analyze and draw meaning from the data.

- communicating with faculty and with one another using electronic mail to post notices, inform others of meetings, ask for advice, and conduct the day-to-day business of running a school

- preparing reports and presentations, for the school board or other professional purposes, with the most powerful analytical and presentation graphics tools available

- conducting the business of the school, from attendance to scheduling to student record-keeping, with labor-saving computerized tools

- communicating with colleagues across the state and nation through the capabilities of telecommunication.